

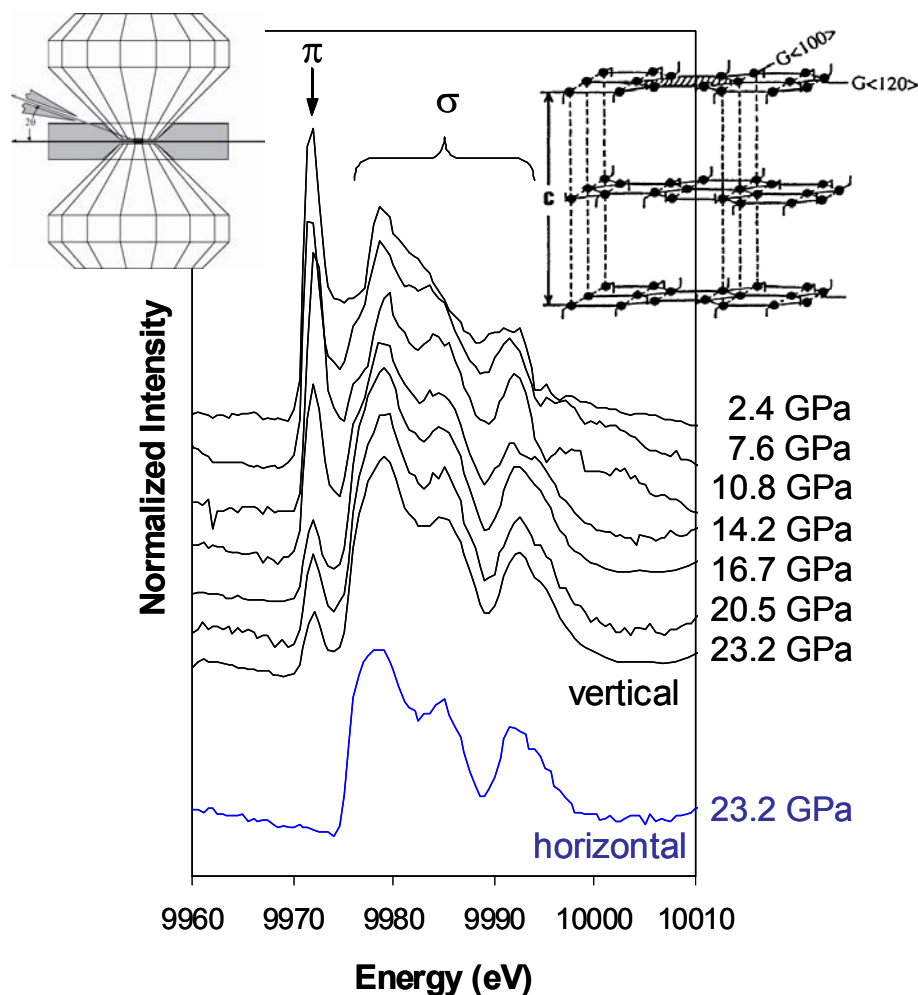
Bonding Changes in Compressed Superhard Graphite

Russell J. Hemley, Carnegie Institution of Washington

DMR-0205899

The unusual room-temperature transition in graphite at 17 GPa (170 kbar) has been a puzzle for 40 years. Near K-edge spectroscopy of carbon using new synchrotron x-ray inelastic scattering techniques reveals that half of the π -bonds between graphite layers convert to σ -bonds, whereas the other half remain as π -bonds in the high-pressure form. The x-ray diffraction pattern of the high-pressure form is consistent with a distorted graphite structure in which bridging carbon atoms between graphite layers pair and form σ -bonds. The high-pressure form is superhard, capable of indenting cubic-diamond single crystals.

W. L. Mao et al., *Science* **302**, 425 (2003)



Inelastic x-ray scattering of graphite under pressure showing the evolution of bonding; two different orientations in the diamond anvil cell were measured.

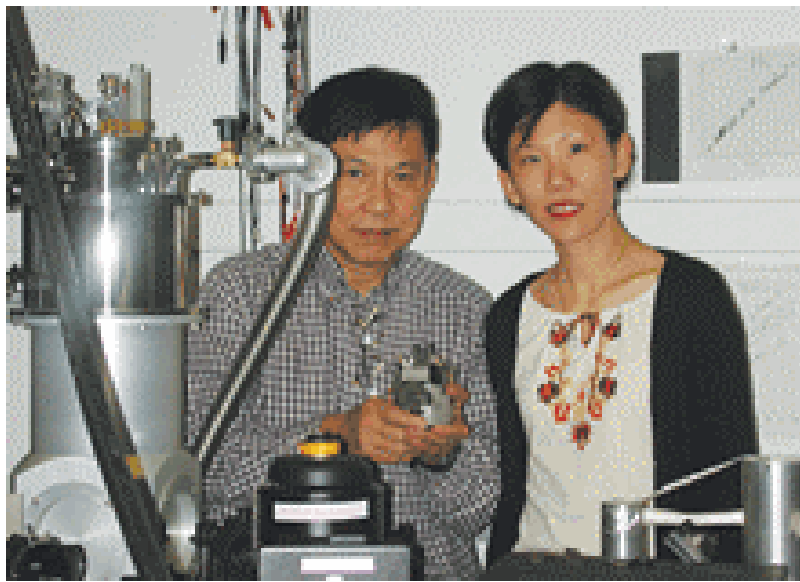
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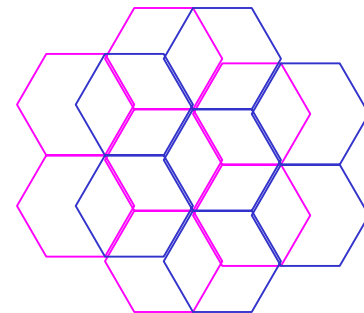
Education:

The project was led by graduate student Wendy Mao of the University of Chicago. The experiments were carried out at the Advanced Photon Source (HPCAT and GSECARS beamlines). Along with Carnegie, these facilities provide strong programs for student training, including summer internships.



Outreach:

The results received considerable attention worldwide in the popular press, and therefore helped to bring these exciting new developments in materials science to a wide audience. Wendy Mao conducted most of the interviews with reporters and journalists.



Left: Photograph of Wendy Mao and her father Ho-kwang Mao at the synchrotron beamline. The photograph was published in Science magazine, in a separate article on young scientists [[Science 301, 5638 \(2003\)](#)]. *Top:* Ring cracks of the diamond anvil from the ultrahard graphite and topology of the bonding in the structure.